UNIVERSITI PUTRA MALAYSIA

SYSTEMATIC APPROACH IN PRECISION FERTILIZER MANAGEMENT FOR HIGH YIELD RICE PRODUCTION IN THE GRANARY AREAS OF PENINSULAR MALAYSIA

ABDUL RAZAK HAMZAH.

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By

ABDUL RAZAK HAMZAH

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirement for the Degree of Doctor of Philosophy

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Chairman : Associate Professor Mohd Fauzi Ramlan, PhD

Faculty : Agriculture

The National Agriculture Policy 3 (NAP3) clearly stated that national-average rice yield of 7.0 t/ha has to be achieved in order to fulfill self-sufficiency level of 65% by 2010. Recently, the set yield target was revised to 10.0 t/ha by the Ministry of Agriculture and Agro-based Industry (MOA). It is a well-known fact that fertilizer is one of the major inputs required to achieve good crop performance and high yield production. Emphasis is given to the granary areas where there is a higher potential to achieve the set yield target. The aim of this study is to develop systematic approaches in location-specific fertilizer management for high-yield rice production within the granary areas.

In order to satisfy the main objective of this study, two types of data namely primary and secondary data were collected, gathered, and compiled. Primary data

was gathered from experimental studies that were conducted throughout granary areas. The data was analyzed and used to develop location-specific fertilizer management technology package, as well as for package verification studies. Secondary data was compiled from soil survey report and used to run the package for estimating fertilizer recommendation rate on large-scale operational basis. It was also used to estimate location-specific potential yield and to set practical yield target for various locations.

The radiation potential yield of variety MR219 of granary areas was estimated using Rice Supply and Demand Analysis (RSDA) model. Based on the potential yield performance, the granary areas were broadly grouped into three cropping zones namely Northeastern, Northwestern, and Central Western Zones. Attainable yield as affected by radiation level and indigenous soil fertility status was estimated using Crop-Environment Resource Synthesis (CERES) Rice model. Variation of attainable yield is markedly represented by the Northeastern Zone that covers three granaries namely Kemubu Irrigation Scheme (KADA), Kemasin-Semerak Irrigation Scheme, and Besut Irrigation Scheme (KETARA). Thus in this study the Northeastern cropping zone was chosen to develop the attainable yield map.

In modern farming where managers are exposed to advance technology and up to date facilities, location-specific computerized fertilizer recommendation tool can be handled easily. Development of computerized fertilizer-management technology tool (FERTO) for location-specific fertilizer recommendation was able

to assist managers to improve crop yield performance and achieve set high-yield target. Verification result shows model under estimated of set yield target (10 t/ha) of about 9%. The package was also used to estimate the amount of fertilizer required by all granaries for two cropping seasons. Benefit cost ratio of about 2:1 for the package could be achieved as compared to subsidy fertilizer of about 1.5:1 only. However, generalization and simplification of the detail information for policy formulation is necessary. Using this approach, 14 reliable fertilizer management zones were identified. This information is useful in developing revised subsidy fertilizer scheme in order to achieve the set national average yield target of 7 t/ha.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PENDEKATAN SISTEMATIK DALAM PENGURUSAN PEMBAJAAN PERSIST UNTUK PENGELUARAN HASIL TINGGI PADI DI KAWASAN JELAPANG SEMENANJUNG MALAYSIA

Oleh

ABDUL RAZAK HAMZAH

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Pengerusi : Profesor Madya Mohd Fauzi Ramlan, PhD

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Dasar Pertanian Negara Ke-3 (DPN3) jelas menyatakan purata hasil padi 7 t/ha perlu dicapai bagi memenuhi tahap saradiri negara sebanyak 65% pada tahun 2010. Terkini, Kementerian Pertanian dan Industri Asas Tani telah mengkaji semula sasaran hasil dan menetapkan pada tahap 10 t/ha. Fakta yang diketahui umum, bahawa baja adalah input utama bagi meningkatkan kualiti tanaman dan pengeluaran hasil tinggi. Penekanan dibuat ke atas kawasan jelapang yang berpotensi mencapai sasaran hasil tinggi. Objektif kajian ini adalah untuk membangun satu pendekatan yang sistematik dalam teknologi pengurusan pembajaan di lokasi spesifik untuk pengeluaran hasil tinggi padi di kawasan jelapang.

Untuk memenuhi objektif utama kajian ini, dua jenis data yang terdiri dari data primer dan data sekunder telah dikutip, dikumpul dan disusun. Data primer diperolehi dari kajian yang dijalankan di kawasan jelapang. Data ini dianalisis dan digunakan untuk membangunkan pakej teknologi pengurusan pembajaan di lokasi spesifik dan menentusahkan pakej tersebut. Data sekunder pula dikumpul dari laporan penilaian tanah, dan digunakan untuk menjalankan pakej bagi menentukan kadar pembajaan dalam operasi perladangan berskala besar. Ia juga digunakan untuk menganggarkan potensi hasil di lokasi spesifik dan menentukan sasaran hasil yang praktikal diberbagai lokasi.

Potensi hasil radiasi varieti MR219 untuk kawasan jelapang telah dianggarkan menggunakan Model RSDA. Berdasarkan potensi pencapaian hasil tersebut, kawasan jelapang telah dibahagikan kepada tiga zon tanaman yang utama iaitu Zon Timur Laut, Zon Barat Laut dan Zon Tengah. Hasil yang mampu dicapai dipengaruhi oleh kadar radiasi solar dan status kesuburan tanah, telah dianggarkan menggunakan model CERES-Rice. Perubahan yang besar hasil yang mampu dicapai ditunjukkan di Zon Timur Laut yang meliputi tiga kawasan jelapang iaitu Skim Pengairan Kemubu (KADA), Skim Pengairan Kemasin-Semerak dan Skim Pengairan Besut (KETARA). Oleh itu Zon Timur Laut telah dipilih untuk diplotkan sebagai mewakili peta hasil mampu-capai.

Dalam bidang pertanian moden di mana pengurus ladang sentiasa didedahkan dengan teknologi moden dan peralatan terkini, peralatan berkomputer untuk syor penggunaan baja di lokasi spesifik berupaya dikendalikan dengan mudah dan

berkesan. Pembentukan teknologi perisian pengurusan baja (FERTO) bagi syor pembajaan di lokasi spesifik telah membantu pengurus ladang meningkatkan pencapaian hasil ke arah sasaran hasil yang ditetapkan. Keputusan verifikasi menunjukkan perbezaan pencapaian hasil yang ditetapkan oleh model berbanding hasil sebenar di ladang adalah lebih rendah iaitu pada tahap 9%. Pakej FERTO turut digunakan untuk menganggarkan jumlah baja yang diperlukan oleh semua kawasan jelapang pada dua musim menanam. Nisbah faedah:kos pada kadar 2:1, mampu dicapai oleh pakej FERTO berbanding dengan 1.5:1 sahaja dengan baja subsidi. Walau bagaimanapun, maklumat yang lengkap perlu diambilkira secara umum dan ringkas dalam pembentukan polisi. Melalui pendekatan ini 14 zon pengurusan pembajaan telah dikenalpasti. Maklumat ini berguna untuk merangka satu kajian semula terhadap skim baja subsidi bagi menyokong petani mencapai sasaran purata hasil negara iaitu 7 t/ha.

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I certify that an Examination Committee met on 7th September 2005 to conduct the final examination of Abdul Razak Hamzah on his Doctor of Philosophy thesis entitled "Systematic Approach in Precision Fertilizer Management for High Yield Rice Production in the Granary Areas of Peninsular Malaysia" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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This thesis submitted to the Senate University Putra Malaysia has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Putra Malaysia or other institutions.

ABDUL RAZAK HAMZAH

Date: 2nd June 2005

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LIST OF ABBREVIATIONS

Al	Aluminium
B	Boron
Ca	Calcium
CCT	Crop Cutting Test
CEC	Cation Exchange Capacity
CERES	Crop Environment Resource Synthesis
CM	Chicken Manure
CSI	Crop Season I
CSII	Crop Season II
Cu	Copper
DAS	Day After Seeding
DEM	Digital Elevation Model
DOA	Department of Agriculture
DRIS	Diagnosis and Recommendation Integrated System
DSS	Decision Support System
EDP	Electronic Data Processing
ESNM	Expert System of Nutrient Management
FAO	Food and Agriculture Organization
Fe	Iron
FELCRA	Federal Land Consolidation and Rehabilitation Authority
FERTO	Fertilizer Management Technology Tool
GDP	Gross Domestic Product
GIS	Geographic Information System

HYV	High Yielding Variety
IADP	Integrated Agriculture Development Project
IBSNAT	International Benchmark Sites Networking for Agrotechnology Transfer
ICT	Information and Communication Technology
IRRI	International Rice Research Institute
IT	Information Technology
K	Potassium
KADA	Kemubu Agriculture Development Authority
KETARA	'Projek Kemajuan Terengganu Utara'
LAI	Leaf Area Index
MADA	Muda Agriculture Development Authority
MARDI	Malaysian Agricultural Research and Development Institute
MDS	Minimum Data Set
Mg	Magnesium
MIS	Management Information Systems
MMS	Malaysian Meteorological Services Department
Mn	Manganese
MOA	Ministry of Agriculture
MOP	Muriate of Potash
N	Nitrogen
NAP3	National Agriculture Policy 3
P	Phosphorus
PBLS	'Projek Barat Laut Selangor'

R&D	Research and Development
RMSE	Root Mean Square Error
RSDA	Rice Supply and Demand Analysis model
RYSTPAP	Rice Yield Estimation for Potential and Attainable Production model
S	Sulfur
SSL	Self-sufficiency Level
TSP	Triple Super Phosphate
VNR	Variable Nutrient Ratio
WTO	World Trade Organization
Y80	Yield at 80% chance to happen
Yn	Nutrient-limited Yield
Yp	Potential Yield
Ys	Simulated Yield
Yw	Water-limited Yield
Zn	Zinc